

WE CLAIM:

1. An integrated coal gasification combined cycle power generator (IGCC) comprising:

a coal gasification system for producing a combustible gas from coal, wherein
5 said gasification system supplies said combustible gas to a gas turbine system;

said gas turbine system comprises a gas turbine for performing expansion work using said combustible gas, wherein said gas turbine supplies exhaust gas to a heat recovery system;

10 said heat recovery system performs heat exchange, wherein said heat recovery system uses said exhaust gas supplied from said gas turbine as a heat source, and is adapted to supply the steam generated in the heat exchange to a steam turbine system;

15 said steam turbine system performs expansion work, said steam turbine system comprising a condenser to condense steam into water, said water being supplied to a heat exchanger in said coal gasification system, where said water is heated to steam, and wherein said steam from said heat exchanger is supplied to at least one section of the gas turbine system which is at a temperature higher than the temperature of said steam (high-temperature section).

2. An IGCC according to claim 1, wherein a higher-temperature steam is produced from said steam after cooling said high-temperature section of the gas turbine system with said steam, said higher-temperature steam is recovered from said high-temperature section of the gas turbine system and supplied to a steam turbine in said steam turbine system.

3. An IGCC according to claim 2, wherein said high temperature section of the gas turbine system is at least one of said gas turbine and a gas turbine combustor.

25 4. An IGCC according to claim 3, further comprising a gasification substance producing unit in said coal gasification system for producing an oxygen gas and a nitrogen gas from air, said gasification substance producing unit being adapted to supply said oxygen gas to a coal gasification unit, wherein:

30 said coal gasification unit is adapted to receive said oxygen gas from said gasification substance producing unit and to receive coal from a coal supplying unit;

said coal gasification unit burns the coal from said coal supplying unit with the oxygen gas from said gasification substance supplying unit, producing said combustible gas and introducing said combustible gas into a cooling unit;

said cooling unit cools said combustible gas from said coal gasification unit, said cooling unit being in fluid connection with a gas cleanup unit; and

said gas cleanup unit removes impurities from said combustible gas.

5 5. An IGCC according to claim 4, wherein said coal supplying unit employs nitrogen gas from said gasification substance producing unit.

6. An IGCC according to claim 5, wherein the nitrogen gas produced in said gasification substance producing unit is supplied to said gas turbine combustor, said nitrogen gas combined therein with said combustible gas.

10 7. An IGCC according to claim 6, wherein said gas turbine system comprises an air compressor that supplies air to at least one high temperature section of the gas turbine system for the purpose of cooling said high-temperature section, producing a higher-temperature air, and wherein

said higher-temperature air is recovered after cooling said high-temperature section and supplied to said heat recovery system.

15 8. An IGCC according to claim 5, further comprising:

a detector for detecting a calorific value of said combustible gas from said gas cleanup unit; and

a controller for controlling the flow rate of said combustible gas based on said calorific value.

20 9. An IGCC according to claim 5, further comprising:

a detector for detecting a calorific value of said combustible gas from said gas cleanup unit; and

a controller for controlling the flow rate of high pressure air from an air compressor based on said calorific value.

25 10. An IGCC according to claim 1, wherein a higher-temperature steam is produced from said steam after cooling said high-temperature section of the gas turbine system with said steam, and wherein

said higher-temperature steam is recovered from said high-temperature section of the gas turbine system and supplied to said heat recovery system.

30 11. An IGCC according to claim 10, wherein said high temperature section of the gas turbine system is at least one of said gas turbine and a gas turbine combustor.

12. An IGCC according to claim 11, comprising a gasification substance producing unit in said coal gasification system for producing an oxygen gas and a nitrogen

gas from air, said gasification substance producing unit being adapted to supply said oxygen gas to a coal gasification unit, wherein

said coal gasification unit is adapted to receive said oxygen gas from said gasification substance producing unit and to receive coal from a coal supplying unit,

5 said coal gasification unit burns the coal from said coal supplying unit with the oxygen gas from said gasification substance supplying unit, producing a combustible gas and introducing said combustible gas into a cooling unit,

said cooling unit cools the combustible gas from said coal gasification unit, said cooling unit being in fluid connection with a gas cleanup unit, and

10 said gas cleanup unit removes impurities from said combustible gas.

13. An IGCC according to claim 12, wherein said coal supplying unit uses nitrogen gas from said gasification substance producing unit.

14. An IGCC according to claim 10, wherein air generated in an air compressor in said gas turbine system is supplied to at least one high temperature section of the gas turbine system for the purpose of cooling said high-temperature section, producing a higher-temperature air, said higher-temperature air is recovered after cooling said high-temperature section and supplied to said heat recovery system.

15 15. An IGCC according to claim 1, wherein said higher-temperature steam is recovered from said high-temperature section of the gas turbine system and supplied to said heat recovery system and to said steam turbine.

20 16. An integrated coal gasification combined cycle power generator comprising:

a coal gasification system for producing a combustible gas from coal, wherein said gasification system supplies said combustible gas to a gas turbine system;

25 said gas turbine system comprises a gas turbine for performing expansion work using said combustible gas, wherein said gas turbine supplies exhaust gas to a heat recovery system;

said heat recovery system performs heat exchange, wherein said heat recovery system uses said exhaust gas supplied from said gas turbine as a heat source, and is adapted to supply the steam generated in the heat exchange to a steam turbine system;

30 said steam turbine system performs expansion work, said steam turbine system comprising a condenser to condense steam into water, said water being supplied to a heat exchanger in said coal gasification system, where said water is heated to steam, and

wherein the steam generated in said heat exchanger is supplied to a driving turbine adapted to power an air compressor.

17. An IGCC according to claim 16, wherein steam is recovered from said driving turbine and supplied to said condenser.

5 18. An integrated coal gasification combined cycle power generator (IGCC) comprising:

a coal gasification system for producing a combustible gas from coal, wherein said gasification system supplies said combustible gas to a gas turbine system;

10 said gas turbine system, comprising a gas turbine, performs expansion work using said combustible gas, wherein said gas turbine supplies exhaust gas to a heat recovery system;

15 said heat recovery system performs heat exchange, wherein said heat recovery system uses said exhaust gas supplied from said gas turbine as a heat source, and wherein said heat recovery system is adapted to supply steam generated in said heat recovery unit to at least one section of the gas turbine system which is at higher temperature than the steam (high-temperature section) to cool said higher temperature section.

20 19. An IGCC according to claim 18, wherein a higher-temperature steam is produced from said steam after cooling said high-temperature section of the gas turbine system with said steam, said higher-temperature steam is recovered from said high-temperature section of the gas turbine system and supplied to a coal gasifier in said coal gasification system.

20. An integrated coal gasification combined cycle power generator (IGCC) comprising:

25 a coal gasification system for producing a combustible gas from coal, wherein said gasification system supplies said combustible gas to a gas turbine system;

said gas turbine system comprises a gas turbine for performing expansion work using said combustible gas, wherein said gas turbine supplies exhaust gas to a heat recovery system;

30 said heat recovery system performs heat exchange, wherein said heat recovery system uses said exhaust gas supplied from said gas turbine as a heat source, and is adapted to supply the steam generated in the heat exchange to a steam turbine system;

said steam turbine system performs expansion work, said steam turbine system comprises a steam turbine, and condenser to condense steam into water, said water being

supplied to a heat exchanger in said coal gasification system, where said water is heated to steam, and wherein said steam from said heat exchanger is supplied to said steam turbine.

21. An IGCC according to claim 20, wherein:

a gasification substance producing unit in said coal gasification system produces
5 an oxygen gas and a nitrogen gas from air, said gasification substance producing unit supplies said oxygen gas to a coal gasification unit;

said coal gasification unit being adapted to receive said oxygen gas from said gasification substance producing unit and to receive coal from a coal supplying unit, wherein said coal gasification unit burns the coal from said coal supplying unit with the
10 oxygen gas from said gasification substance supplying unit, producing said combustible gas and introducing said combustible gas into a cooling unit;

said cooling unit cools said combustible gas from said coal gasification unit, said cooling unit being in fluid connection with a gas cleanup unit; and

said gas cleanup unit removes impurities from said combustible gas.

22. An IGCC according to claim 21, wherein the nitrogen gas generated in said gasification substance producing equipment is supplied to at least one high-temperature section of the gas turbine system for the purpose of cooling said high temperature section, producing a higher-temperature nitrogen gas, and wherein

said higher-temperature nitrogen gas is recovered after cooling at least one high-
20 temperature section of said gas turbine system and is supplied to a gas turbine combustor.

23. An IGCC according to claim 22, wherein the nitrogen gas generated in said gasification substance producing equipment is supplied to at least one high-temperature section of the gas turbine system for the purpose of cooling said high temperature section, producing a higher-temperature nitrogen gas, and wherein

said higher-temperature nitrogen gas is recovered after cooling at least one high-
25 temperature section of said gas turbine system and is supplied to said gas cleanup unit.

24. An IGCC according to claim 20, wherein said heat recovery system comprises a first and second heat exchanger, and wherein both heat exchangers use water to cool said exhaust gas from said gas turbine, and both generate steam from said water.

25. An IGCC according to claim 24, wherein said steam generated in said second heat exchanger is recovered from said second heat exchanger and is supplied to at least one high-temperature section of said gas turbine system, producing a higher-
30 temperature steam.

26. An IGCC according to claim 25, wherein said higher-temperature steam is recovered after cooling said high-temperature section of the gas turbine system and is supplied to said coal supplying unit.

27. An IGCC according to claim 25, wherein said higher-temperature steam is recovered after cooling the high-temperature section of said gas turbine system and is supplied to said first heat exchanger.

28. An IGCC according to claim 20, wherein said heat recovery system comprises a first and second heat exchanger, and wherein both heat exchangers cool said exhaust gas from said gas turbine.

29. An IGCC according to claim 28, comprising a steam turbine system comprising a low-pressure turbine and a high-pressure turbine for performing expansion work by steam received from said first and second heat exchangers.

30. An IGCC according to claim 29, wherein said high pressure turbine receives steam from said first heat exchanger and said low pressure turbine receives steam from said second heat exchanger, and wherein said low pressure turbine provides steam to a condenser.

31. An IGCC according to claim 30, wherein said second heat exchanger receives steam from said gas turbine and from said high pressure turbine.

32. A method of improving the thermal efficiency of an IGCC comprising using an IGCC in accordance with ~~any~~ of claims 1-31.